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**Gilmore**

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(54) **LINE STRUCTURE FOR MARINE USE IN CONTAMINATED ENVIRONMENTS**

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**D02G 3/22** (2006.01)

(52) **U.S. Cl.** ..... **57/211**

(58) **Field of Classification Search** ..... 57/210-235  
See application file for complete search history.

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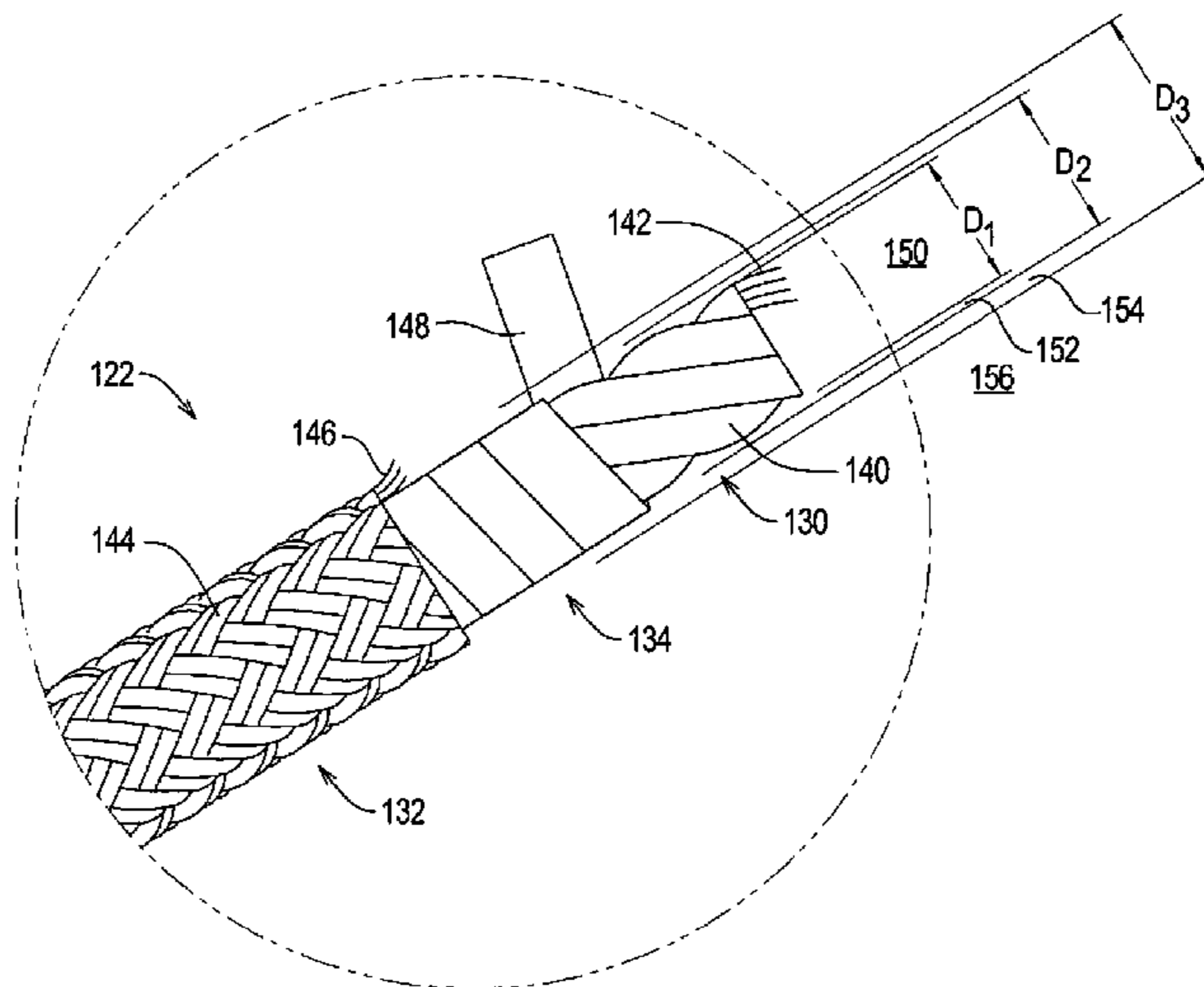
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(57) **ABSTRACT**

The present invention may be embodied as a line structure for use as a mud line assembly. In this case, the line structure comprises a plurality of strands, and each of the strands comprises a core portion, a jacket portion, and a barrier portion. The barrier portion is arranged between the core portion and the jacket portion to inhibit movement of contaminate material into the core portion.

**19 Claims, 2 Drawing Sheets**



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FIG. 1

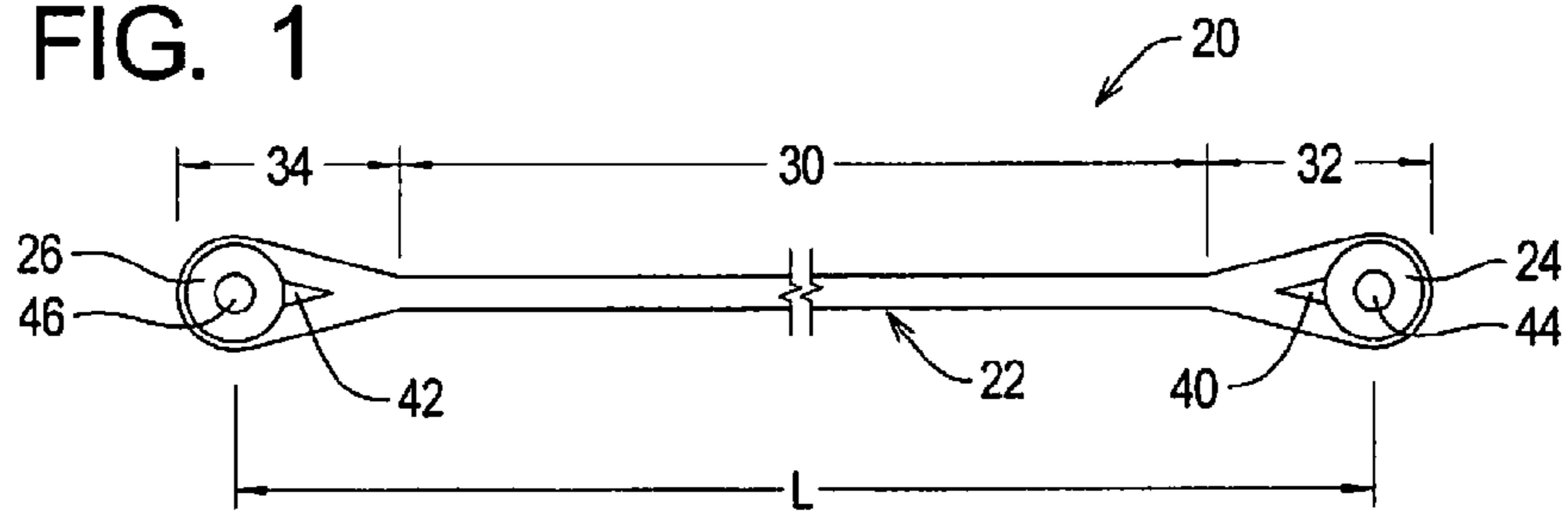


FIG. 2

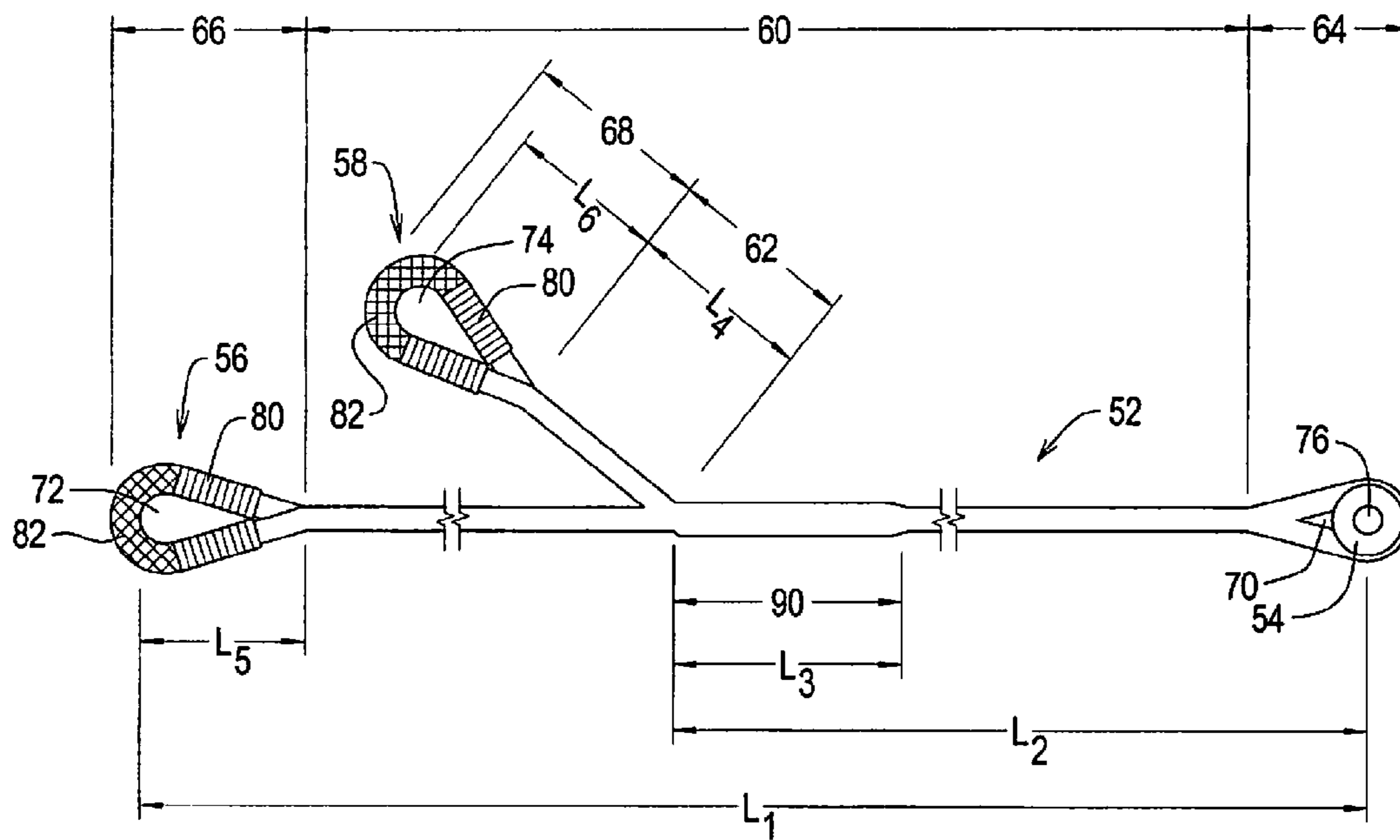


FIG. 3

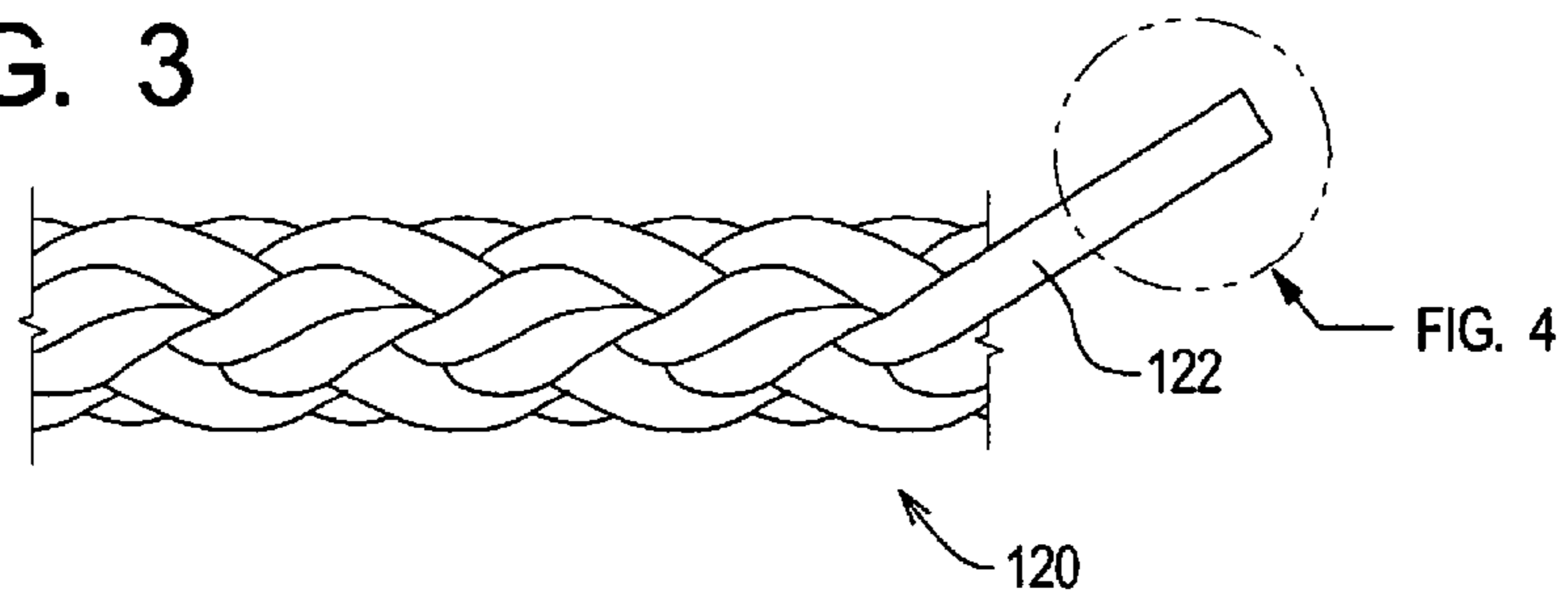
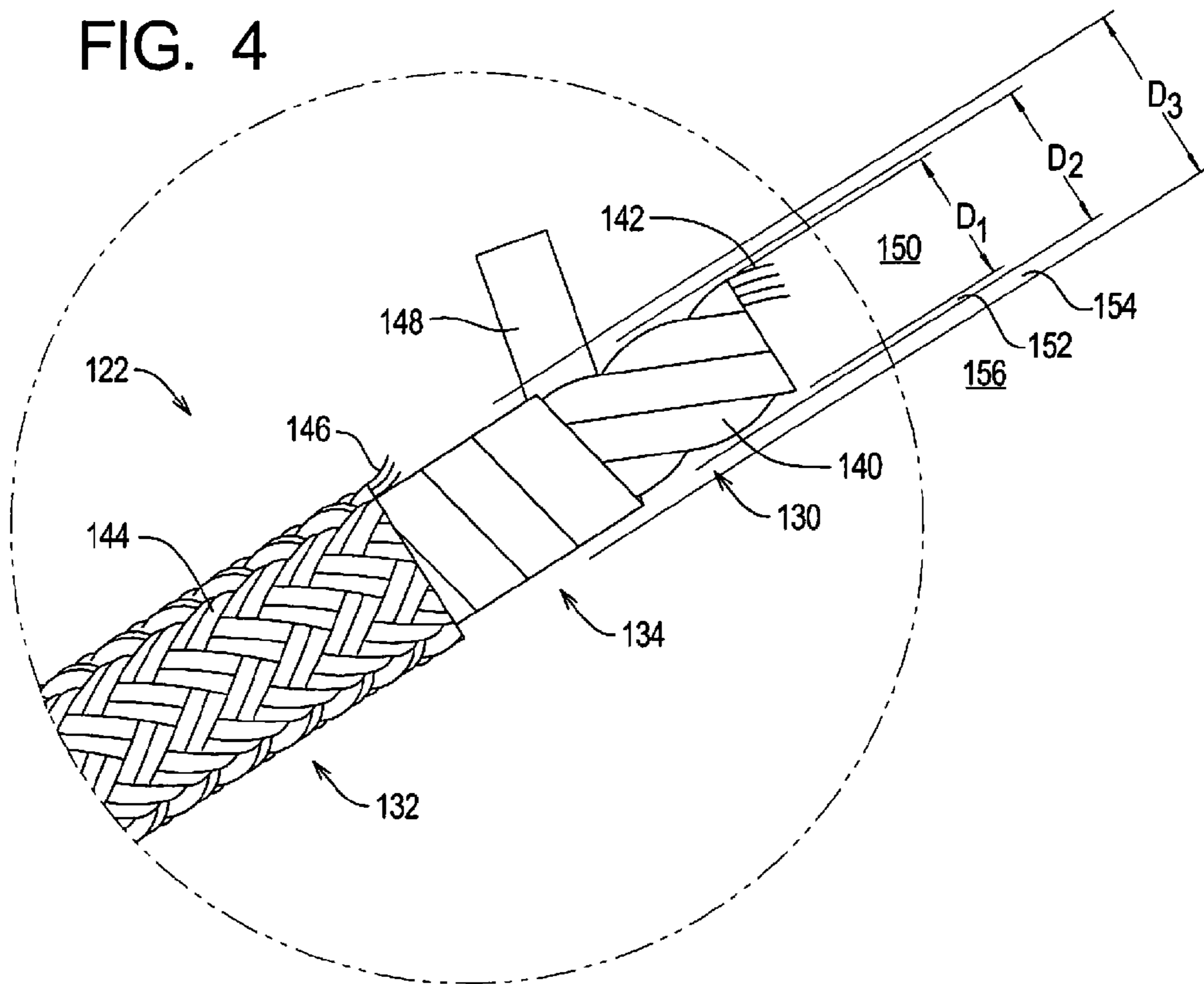


FIG. 4



## LINE STRUCTURE FOR MARINE USE IN CONTAMINATED ENVIRONMENTS

### RELATED APPLICATIONS

This application claims priority of U.S. Provisional Patent Application Ser. No. 61/127,881 filed May 16, 2008, the contents of which are incorporated herein by reference.

### TECHNICAL FIELD

The present invention relates to lines for use in marine environments and, more particularly, to lines designed for use in applications where at least a portion of the line is in a contaminated environment such as on or below the surface of the sea floor.

### BACKGROUND

The term "mud line" is conventionally used in the petroleum industry to refer to the boundary between earth and water. An anchor assembly used as part of an offshore anchoring system is typically submerged in the silt and mud defining the mud line at the bottom of the body of water. Conventional anchor assemblies typically employ chains, wires, or cables made of metal. The need exists for improved anchor assemblies and line structures for use as part of anchor assemblies.

### SUMMARY

The present invention may be embodied as a line assembly comprising a line structure comprising a plurality of strands, where each of the strands comprises a core portion, a jacket portion, and a barrier portion. The barrier portion is arranged between the core portion and the jacket portion to inhibit movement of contaminate material into the core portion.

The present invention may also be embodied as a line structure for use as a mud line assembly. In this case, the line structure comprises a plurality of strands, and each of the strands comprises a core portion, a jacket portion, and a barrier portion. The barrier portion is arranged between the core portion and the jacket portion to inhibit movement of contaminate material into the core portion.

The present invention may also be embodied as a line assembly comprising a line structure comprising a plurality of strands, where each of the strands comprises a core portion, a jacket portion, and a barrier portion comprising filter material. The filter material is arranged around the core portion to inhibit movement of contaminate material into the core portion.

### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a first example line assembly constructed in accordance with, and embodying, the principles of the present invention;

FIG. 2 is a perspective view of a second example line assembly constructed in accordance with, and embodying, the principles of the present invention;

FIG. 3 is a view of a section of the first and second example line assemblies depicted in FIGS. 1 and 2; and

FIG. 4 is a view of a section of an example strand that may be used as part of the first and second example line assemblies depicted in FIGS. 1 and 2.

### DETAILED DESCRIPTION

Referring initially to FIG. 1 of the drawing, depicted therein is a first example line assembly 20 of the present

invention comprising a line member 22 and optional first and second thimbles 24 and 26. The line member 22 defines an intermediate portion 30 and first and second end portions 32 and 34. The first and second end portions 32 and 34 define first and second end openings 40 and 42, respectively. The end portions 32 and 34 are or may be formed by conventional techniques for terminating line structures.

If used, the thimbles 24 and 26 are arranged within the end openings 40 and 42, respectively, in a conventional manner. The thimbles 24 and 26 are or may be conventional and define generally circular thimble openings 44 and 46, respectively. The thimbles 24 and 26 are designed to protect the line member 22 while transferring to the line member 22 loads from other components (not shown) of the anchoring system in which the line assembly 20 is used.

The first example line assembly 20 defines a length L between the centers of the thimble openings 44 and 46. The length L of the example line assembly 20 is approximately 335 feet; however the length of any line assembly constructed in accordance with the principles of the present invention will be determined based on the particular operating conditions under which the line assembly is to be used.

Turning now to FIG. 2 of the drawing, depicted therein is a second example line assembly 50 comprises a line member 52, an optional thimble 54, and optional first and second protection assemblies 56 and 58. The line member 52 defines an intermediate portion 60, a deployment portion 62, and first, second and third end portions 64, 66, and 68. The first, second, and third end portions 64, 66, and 68 define first, second, and third end openings 70, 72, and 74, respectively. The end portions 64, 66, and 68 are or may be formed by conventional techniques for terminating line structures.

The thimble 54 is arranged within the first end opening 70 in a conventional manner. The thimble 54 is or may be conventional and defines a generally circular thimble opening 76. The thimble opening 76 is designed to transfer to the line member 52 loads from other components (not shown) of the anchoring system in which the line assembly 50 is used.

The protection structures 56 and 58 are arranged to cover portions of the second and third end portions 66 and 68 of the line member 52 defining the second and third end openings 72 and 74, respectively. The example protection structures 56 and 58 each comprise a whipping structure 80 and a chafe structure 82. The whipping structure 80 is first wrapped around portions of the second and third end portions 66 and 68 of the line member 52. The chafe structure 82 is then wrapped around at least a portion of the whipping structure 80. The protection structures 56 and 58 are or may be formed in a conventional manner and are designed to protect the line member 52 when the line assembly 50 is connected to other components (not shown) of the anchoring system in which the line assembly 50 is used.

The second example line assembly 50 defines a primary length  $L_1$  between the center of the thimble opening 76 and the inside surface of the second end portion 66 defining the second end opening 72. The second example line assembly 50 further defines a secondary length  $L_2$  between the center of the thimble opening 76 and the point at which the deployment portion 62 extends from the intermediate portion 60. The example deployment portion 62 is spliced into the intermediate portion 60 over a splice area 90 having a splice length  $L_3$ . The deployment portion 62 defines a deployment length  $L_4$ . The second and third end portions 66 and 68 define first and second end lengths  $L_5$  and  $L_6$ , respectively.

In the example line assembly 50, the primary length  $L_1$  is approximately 105 feet, the secondary length  $L_2$  is approximately 37 feet, the splice length  $L_3$  is approximately 12 feet,

the deployment length  $L_4$  is approximately 10 feet, and the first and second end lengths  $L_5$  and  $L_6$ , are approximately 8 feet. Again, the lengths of any line assembly constructed in accordance with the principles of the present invention will be determined based on the particular operating conditions under which the line assembly is to be used.

The line members **22** and **52** may differ in construction, composition, geometry, and dimensions, but share certain characteristics that render these members **22** and **52** appropriate for use as part of the line assemblies **20** and **50** described above. In addition, the characteristics shared by the line members **22** and **52** may be configured for use as part of any line system or assembly that will be subjected to operating conditions similar to those encountered by the example line assemblies **20** and **50** described herein. In the following discussion, an example line structure that may be used to form the line members **22** and **52** will be described in further detail.

Referring now to FIGS. **3** and **4** of the drawing, depicted therein is an example line structure **120** that may be used to form the example line members **22** and **52** or any other line member designed for use under similar operating conditions. The example line structure **120** comprises a plurality of strands **122** as shown in FIG. **3**. The strands **122** are combined in any conventional manner to obtain a line structure **120** that meets the load conditions of the intended use environment.

The strands **122** in turn comprise a core portion **130**, a jacket portion **132**, and a barrier portion **134**. The core portion **130** comprises a plurality of core yarns **140** comprising core fibers **142**, while the jacket portion **132** comprises a plurality of jacket yarns **144** comprising a plurality of jacket fibers **146**. The core yarns **140** and jacket yarns **144** in turn may comprise a plurality of components such as smaller yarns or bundles of fibers. The barrier portion **134** comprises at least one strip of barrier material **148** that is arranged between the core portion **130** and the jacket portion **132**.

The example strands **122** thus define an interior region **150** that is substantially but not completely occupied by the core fibers **142** forming the core portion **130**. In cross-section, the interior region **150** is substantially in the shape of a circle having a core diameter  $D_1$ . The example strands **122** further define a barrier region **152** that is substantially occupied by the barrier material **148**. In cross-section, the barrier region is substantially annular, with an inner diameter of equal to the core diameter  $D_1$  and an outer diameter equal to a barrier diameter  $D_2$ . The example strands **122** further define a jacket region **154** that is substantially occupied by the jacket fibers **146** defining the jacket portion **132**. In cross-section, the jacket region **154** is substantially annular, with an inner diameter of equal to the barrier diameter  $D_2$  and an outer diameter equal to a jacket diameter  $D_3$ . The jacket diameter  $D_3$  defines the nominal diameter of the example strands **122**. An exterior region **156** is defined as anything outside of the outer boundaries of the barrier region **152**.

The barrier material **148** is arranged to inhibit movement of contaminate material from the exterior region **156** to the interior region **150**. Contaminate material is any foreign matter not present in the line structure **120** when originally manufactured. In general, contaminate material enters line structures over time. When mixed in with the fibers forming a line structure, contaminate material can be detrimental to the operation and/or wear life of the line structure.

In the context of a line structure intended for use as an anchor assembly or under similar conditions, the line structure is often submerged under pressure in a liquid bath of fine particles suspended within water. The applicant has determined that, under pressure and movement of the line structure, the suspended particles easily flow within the rope struc-

ture. The Applicant has further determined that problems associated with the intrusion of contaminate material are exacerbated in the context of a line structure designed for use as part of an anchor assembly or the like because contaminate material between and around the fibers forming the line structure degrades the line structure and can cause failure thereof.

In the context of the example line structure **120**, the core portion **130** forms the prime load bearing element of the line structure **120**. The barrier material **148** is arranged to inhibit contamination of the core portion **130** by contaminate material, even though the entire line structure **120** may be submerged within a fluid bath comprising particulates. The barrier material **148** thus improves abrasion resistance of the overall line structure **120**. The operation and/or wear life of the core fibers **142** is thus less likely to be adversely affected by contaminate material.

The example barrier material **148** is designed to prevent egression of particulate material down to 2 microns in size (i.e., greater than approximately 2 microns). The exact specifications of the barrier material **148** can be selected based on the particular environment in which the line structure **120** is to be used.

The example barrier material **148** is a strip of filter tape that is wrapped in a helical configuration around the core portion **130** with edges of the filter tape overlapping as perhaps best shown at **160** in FIG. **4**. Accordingly, when wrapped around the entire core portion **130**, the filter tape forming the barrier material **148** forms a continuous barrier in the barrier region **152** that inhibits the egression of particulate from the exterior region **156** to the interior region **150**.

The filter tape forming the barrier material **148** may comprise adhesive material on one side such that the barrier material **148** adheres to itself and to the core portion **130**. If used, the adhesive material helps the barrier material to stay in place around the core portion **130**.

In the example line structure **120**, the jacket portion **132** is formed by a tight cover braid of urethane coated jacket fibers **146**. The jacket portion **132** surrounds the barrier material **148**, protecting the barrier material **148** and holding the barrier material **148** in place around the core portion **130**. The jacket portion **132** further provides stiffness to the line structure **120**. Providing stiffness to the line structure **120** aids with ROV connections commonly used when installing, servicing, and removing offshore anchoring systems.

The example strands **122** employ an 8×3 construction. Although other constructions may be possible, the 8×3 construction provides the advantages of both laid and braided ropes.

The core fibers **142** and the jacket fibers **146** of the example line structure **120** employ are formed by high molecular polyethylene (HMPE). HMPE fibers provide good strength and abrasion resistance. HMPE also provides a low specific gravity, meaning that the line structure **120** will float in water. Using a line structure **120** capable of floating in water yields a line member that simplifies the connection of mooring lines and anchor retrieval. Other fibers such as LCPs are also candidates for use in line structures configured for use as anchor line assemblies and the like.

The present invention is of particular significance when used as part of the Delmar Systems Inc. Omni-Max anchoring system, and the two example line assemblies **22** and **52** disclosed herein are configured for use as part of the Omni-Max anchoring system. However, the concepts of the present invention may be applied to any line member intended for use under similar operating conditions.

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What is claimed is:

**1.** A line assembly adapted for underwater use at the boundary between earth and water, comprising:

a line structure comprising a plurality of strands, where each of the strands comprises

a core portion comprising a plurality of core yarns, where each of the core yarns comprises a plurality of core fibers,

a jacket portion comprising a plurality of jacket yarns, where each of the jacket yarns comprises a plurality of jacket fibers, and

a barrier portion provided for each strand; wherein the barrier portion is arranged between the core portion and the jacket portion of each strand to inhibit movement of contaminate material into the core portions of the strands.

**2.** A line assembly as recited in claim 1, in which the barrier portion comprises filter material arranged around each core portion.

**3.** A line assembly as recited in claim 1, in which the barrier portion comprises at least one strip of filter material arranged around each core portion.

**4.** A line assembly as recited in claim 1, in which the barrier portion comprises at least one strip of filter tape arranged around each core portion.

**5.** A line assembly as recited in claim 4, in which the filter tape defines at least one adhesive surface adapted to secure the filter tape to each core portion.

**6.** A line assembly as recited in claim 4, in which the filter tape is wrapped around each core portion in a helical configuration.

**7.** A line assembly as recited in claim 6, in which edges of the filter tape overlap.

**8.** A line assembly as recited in claim 1, in which the barrier portion inhibits movement of particulate material larger than approximately 2 microns.

**9.** A line structure for use as a mud line assembly, where the line structure comprises:

a plurality of strands, where each of the strands comprises a core portion comprising a plurality of core yarns, where each of the core yarns comprises a plurality of core fibers,

a jacket portion comprising a plurality of jacket yarns, where each of the jacket yarns comprises a plurality of jacket fibers, and

a barrier portion provided for each strand; wherein

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the barrier portion is arranged between the core portion and the jacket portion of each strand to inhibit movement of contaminate material into the core portions of the strands.

**10.** A line assembly as recited in claim 9, in which the barrier portion comprises filter material arranged around each core portion.

**11.** A line assembly as recited in claim 9, in which the barrier portion comprises at least one strip of filter material arranged around each core portion.

**12.** A line assembly as recited in claim 9, in which the barrier portion comprises at least one strip of filter tape arranged around each core portion.

**13.** A line assembly as recited in claim 12, in which the filter tape defines at least one adhesive surface adapted to secure the filter tape to each core portion.

**14.** A line assembly as recited in claim 12, in which the filter tape is wrapped around each core portion in a helical configuration.

**15.** A line assembly as recited in claim 12, in which edges of the filter tape overlap.

**16.** A line assembly as recited in claim 9, in which the barrier portion inhibits movement of particulate material larger than approximately 2 microns.

**17.** A line assembly adapted for underwater use in silt and mud at the boundary between earth and water, comprising:

a line structure comprising a plurality of strands, where each of the strands comprises

a core portion comprising a plurality of core yarns, where each of the core yarns comprises a plurality of core fibers,

a jacket portion comprising a plurality of jacket yarns, where each of the jacket yarns comprises a plurality of jacket fibers, and

a barrier portion provided for each strand, where the barrier portion comprises filter material; wherein the filter material is arranged around the core portion of each strand to inhibit movement of contaminate material into the core portions of the strands.

**18.** A line assembly as recited in claim 17, in which the filter material comprises at least one strip of filter tape defining at least one adhesive surface, where the filter tape is wrapped around the core portion in a helical configuration such that edges of the filter tape overlap.

**19.** A line assembly as recited in claim 17, in which the filter material inhibits movement of particulate material larger than approximately 2 microns.

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